THE PHOSPHORUS INTAKE OF PRE-SCHOOL CHILDREN AS SHOWN BY A DIETARY STUDY MADE BY THE INDIVIDUAL METHOD

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THE PHOSPHORUS INTAKE OF PRE-SCHOOL CHILDREN AS SHOWN BY A DIETARY STUDY MADE BY THE INDIVIDUAL METHOD

HUGHINA McKAY

The study reported in this paper was undertaken with the thought of adding something of value to existing knowledge concerning the food needs of children, with particular reference to the phosphorus requirement. It was thought that an accurate record of the food actually eaten by a group of normal healthy children would serve at least as an indication of what children should have and would therefore be of value in setting standards.*

While several studies of the food consumption of children in homes and in institutions have been made in this country by the inventory method by which the total food consumption of a group is determined and the individual consumption estimated as part of the whole (1), as far as the writer knows only two studies besides the one herein reported have been made by the individual method by which the food actually eaten by the individual is determined. Holt and Fales have published the result of such a study (2) and a somewhat similar study has been made by Miss Goodhue (3).

Since these two studies are both of interest in that they have influenced standards of food consumption for children and since the findings from each will be used for comparison in this report, it seems wise to summarize briefly the method and procedure followed in each case.

HOLT AND FALES

The Holt and Fales study included 106 children from the age of 1 to 16 years. These children were all in good physical condition "living in private homes in excellent surroundings. The parents

*These data were collected by Mary Ann Brown, assistant in the Department of Home Economics.

were intelligent people, interested in the purpose of the experiment and willing to cooperate. The children were supposedly intelligently fed and it may be assumed that they were receiving diets fairly typical of those usually taken by well children." (1)

The procedure used is described as follows: "A report of the net weight, height, activity, appetite, general condition, etc., was obtained together with a record of the exact amount of each item of food taken by the child for four consecutive days. From these data the caloric value of the average daily diet was calculated", and the distribution of the calories among protein, fat, and carbohydrate was determined.

Values for food were obtained "for the most part" from Locke. The use of Locke's figures for cooked foods introduces, as has been pointed out elsewhere (3), a chance for "a possibly large error" in that if his figures for prepared dishes are used, the assumption follows that the exact formula used in one case is used in the other. To determine, with any accuracy, the food value of a cooked dish, the food value of each ingredient used must be calculated. This possibility of error has been noted by Holt and Fales, since they state, "This method of estimating the calories taken by children is of course not absolutely accurate, but it undoubtedly gives a very close approximation. While there are slight variations from the usual caloric values of the food owing to differences in the methods of preparing food, it is probable that these errors tend to balance each other and that the net result is approximately accurate."

Altho Holt and Fales considered only the protein, fat, and carbohydrate of the diets of the children studied and did not consider minerals and altho some error incident to the method used is unavoidable, their study is an extremely valuable contribution to information concerning the food needs of children and has undoubtedly aroused consciousness to the fact that the food requirements of children are higher than had previously been considered.

GOODHUE

The study made by Goodhue (3) was also based on the individual method of determining the food intake of children. For a period of one day the food eaten by this selected group of children was weighed. Information of the food consumption for the remainder of the period included in the study was obtained by records made by the parents of the children. Data obtained by both methods were combined and used as a basis for findings. As with the Holt and Fales study, possibilities of error inherent to the

method used are to be seen. Nevertheless this study has much of interest and should also be of value as an aid in setting standards.

Of special interest in connection with this study of Miss Goodhue's is the fact that the calcium, phosphorus, and iron intake of the diets have been calculated and appear in tabular form. The information concerning the amounts of these minerals habitually taken in the diet by healthy normal children as shown in the Goodhue study is a valuable addition to such knowledge as we have concerning the mineral needs of children.

Findings concerning the occurrence of the dietary factors in the food intake of children as shown in each of these two studies will be referred to thruout this report.

METHOD USED IN THE PRESENT STUDY

Since the purpose of this study was to determine the amount of such of the dietary factors as could be calculated in the food that normal healthy children actually take in the accustomed diet, as an aid to setting standards, it was necessary to select children who were in excellent physical condition.

Twenty-five of the children selected lived in private homes. All the parents of this group were intelligent and their interest in the problem was evidenced by their cooperation in giving the young women who collected the data the opportunity of being in the home during meal times for a period of four days. Observations were made on the diets of these children during January, February, and March 1926.

Thirty of the children studied were residents of an orphanage. The interest of the persons in charge of this institution was also evidenced by the most cordial cooperation. Observations were made on the diets of these children during the week beginning January 31, 1926.

The 55 children comprising the group were all examined by the same pediatrician and pronounced normal as to physical condition. None of the children were more than 4 percent below the commonly accepted standard of weight for height while the majority were well above the standard. Table 20 in the appendix gives age, height, and weight of each child as well as the comparison with the standard of weight for height commonly used. In addition data concerning the time of entrance of each child into the orphanage are shown.

To collect the data, young women trained in the method, went into the homes and into the institution and weighed the food eaten

by each child for four consecutive days. Thru the intelligent cooperation of parents and the persons in charge of the orphanage, it was possible to have the children follow their usual habits in regard to the food eaten. They all seemed to take the presence of the young women as a matter of course.

In determining the values of prepared foods such as soup, mashed potatoes, and puddings, the separate ingredients were weighed and their food value was calculated. The weight of the finished product was determined and the weight and food value of the amount each child ate was calculated. Using this procedure accurate figures for the exact food consumption of each child were determined. In the case of some few commercial products, as wafers, cookies, catsup, and marmalade, for which it was impossible to do otherwise, figures already computed from Locke's Manual (4) or from Rose's Feeding the Family (5) or Jordan's Principles of Human Nutrition (6) were used. Such foods did not enter very largely into the diets, and possible errors incident to this procedure seem negligible. In calculating food values, figures from tables given by Sherman in Chemistry of Food and Nutrition (7) have been used in most cases. Samples of some of the foods used were analyzed in the Agricultural Chemistry department at the Ohio State University and some in the chemistry laboratory at the Ohio Agricultural Experiment Station. The data obtained in the manner described were tabulated and classified. The (1) calorie, (2) protein, (3) fat, (4) carbohydrate, (5) calcium, (6) phosphorus, and (7) iron intake of each child for four successive days was determined and averaged. The findings presented are based on these data and will be discussed in the order listed. Vitamin content of diet could be estimated only.

In discussing the data presented the study herein reported will be referred to as the "Ohio study".

CALORIES

In Table 1 total calorie intake and calories per kilogram are recorded for each of the 55 children whose diets were observed. For ease of comparison the children of each sex are divided into groups according to each year of age. Data from this study and other available studies are shown in Table 2. Figures 1 and 2 present this material in graphic form.

Of the 36 children from 3 to 6 years old, 9 girls were having a calorie intake higher than any of the standards given for the cor-

FINDINGS

TABLE 1.—Daily Calorie Intake of Children Included in the Ohio Study

Private Homes			Orphanage		
Child	Total calories	Calories per kg.	Child	Total calories	Calories per kg.
Boys 2 to 3 years					
R. M.	1,262	115.8	T. Z.	1,220	90.3
R. R.	1,204	90.7	R. S.	1,227	85.7
J. A.	1,207	91.3	J. S.	1,287	93.2
H. T.	1,224	83.3	J. H.	1,207	97.3
G. C.	1,469	115.5			
O. B.	1,260	85.8			
J. B.	1,113	83.0			
Average.....	1,249	95.1	Average.....	1,235	91.6
Girls 2 to 3 years					
I. M.	842	74.1	R. R.	1,174	93.9
M. N.	1,450	95.9	B. P.	1,400	91.4
P. P.	1,231	82.5	L. B.	1,150	91.9
P. C.	1,086	82.9			
B. B.	1,153	73.5			
Average.....	1,152	81.8	Average.....	1,241	92.4
Boys 3 to 4 years					
J. W.	1,852	100.5	T. H.	1,299	90.8
G. M.	1,537	93.1	J. C.	1,172	90.8
			D. W.	1,138	66.1
			J. P.	1,244	80.7
			J. DeP.	1,469	99.9
			R H.	1,628	93.0
Average.....	1,694	96.8	Average.....	1,325	86.9
Girls 3 to 4 years					
B. L.	1,411	88.4	T. P.	1,202	89.0
N. H.	996	67.7	H. H.	1,313	94.4
M. W.	1,505	82.8	P. A.	1,224	89.3
R. P.	1,276	90.5	D. H.	1,201	86.4
			K. R.	1,157	84.4
			C. H.	1,328	83.0
Average.....	1,297	82.3	Average.....	1,238	87.8
Boys 4 to 5 years					
J. W.	1,944	93.4	B. H.	1,486	99.0
C. C.	1,633	90.9	T. P.	1,234	81.7
D. W.	1,689	87.4			
R. L.	1,838	82.4			
H. C.	1,719	88.8			
Average.....	1,765	88.6	Average.....	1,360	90.3

FINDINGS

TABLE 1.—Daily Calorie Intake of Children Included in the Ohio Study—Continued

Private Homes			Orphanage		
Child	Total calories	Calories per kg.	Child	Total calories	Calories per kg.
Girls 4 to 5 years					
M. P.	1,651	85.2	P. S.	1,277	95.2
L. M.	1,569	92.0	C. C.	1,556	81.0
			C. H.	1,709	117.7
Average....	1,610	88.6	Average. ..	1,514	95.9
Boys 5 to 6 years					
			D. P.	1,735	78.1
			Average....	1,735	78.1
Girls 5 to 6 years					
			T. Z.	1,386	94.0
			G. W.	1,756	93.8
			B. S.	1,741	93.5
			N. H.	1,753	88.5
			E. P.	1,667	90.6
			Average.....	1,660	92.1
Boys (entire group) 2 to 6 years			Girls (entire group) 2 to 6 years		
Average....	1,418	90.7	Average. ..	1,363	88.1

responding ages and 8 boys higher than any standard except Lusk's. Almost half of the children from 3 to 6, then, had a high calorie intake.

The 19 children comprising the 2 to 3 year old group were eating less when compared to standards, altho 5 of them were eating more than the amounts of the most recently compiled standard, that of Holt and Fales.

While the intakes of the younger children were fairly uniform both in amounts eaten on each of four consecutive days and in total amounts eaten by individual children, some interesting variations were noticed. M. N., who at 2 years and 4 months weighed 15.11 kilograms, was eating 1450 calories, or 96 calories per kilogram, as compared to I. M. who, at 2 years and 1 month weighed 11.36 kilograms, was eating only 842 calories, or 74 calories per kilogram daily. M. N. was also eating more than B. B. who at 2 years and 10 months weighed 15.68 kilograms, very little more than the younger child, but was eating only 1152 calories or 73 calories per kilogram daily.

TABLE 2.—Comparison of Calorie Standards With Averages From Goodhue Study and Ohio Study

Age	Kilos	Atwater		Inter-Allied Food Commis.		Gillett		Lusk		Holt—Fales		Goodhue		Ohio Study				Total Ohio Study	
														Private Home		Orphanage			
		Per kilo	Total cals.	Per kilo	Total cals.	Per kilo	Total cals.	Per kilo	Total cals.	Per kilo	Total cals.	Per kilo	Total cals.	Per kilo	Total cals.	Per kilo	Total cals.	Per kilo	Total cals.
Boys																			
2—3	14.5	83	1,200	103	1,500	69—89	1,000—1,300	117	1,697	88	1,275	80	1,295	95	1,249	92	1,235	94	1,244
3—4	16.4	73	1,200	91	1,500	67—84	1,100—1,400	116	1,902	84	1,380	.....	1,446	97	1,694	87	1,325	89	1,417
4—5	18.2	66	1,200	82	1,500	66—82	1,200—1,500	105	1,911	82	1,490	85	1,427	89	1,765	90	1,360	89	1,649
5—6	20.0	60	1,200	75	1,500	65—80	1,300—1,600	105	2,100	80	1,600	93	2,105	.....	.....	78	1,735	78	1,734
Girls																			
2—3	14.1	85	1,200	106	1,500	69—91	980—1,280	Does not		87	1,230	.....	1,174	82	1,152	92	1,241	86	1,185
3—4	15.9	75	1,200	94	1,500	67—85	1,060—1,360	give any		82	1,300	.....	1,549	82	1,297	88	1,238	86	1,261
4—5	18.2	66	1,200	82	1,500	63—79	1,140—1,440	figures		78	1,410	.....	1,593	89	1,610	96	1,514	93	1,552
5—6	20.0	60	1,200	75	1,500	61—76	1,220—1,520.	for girls		76	1,520	.....	1,946	.....	.....	92	1,661	92	1,661

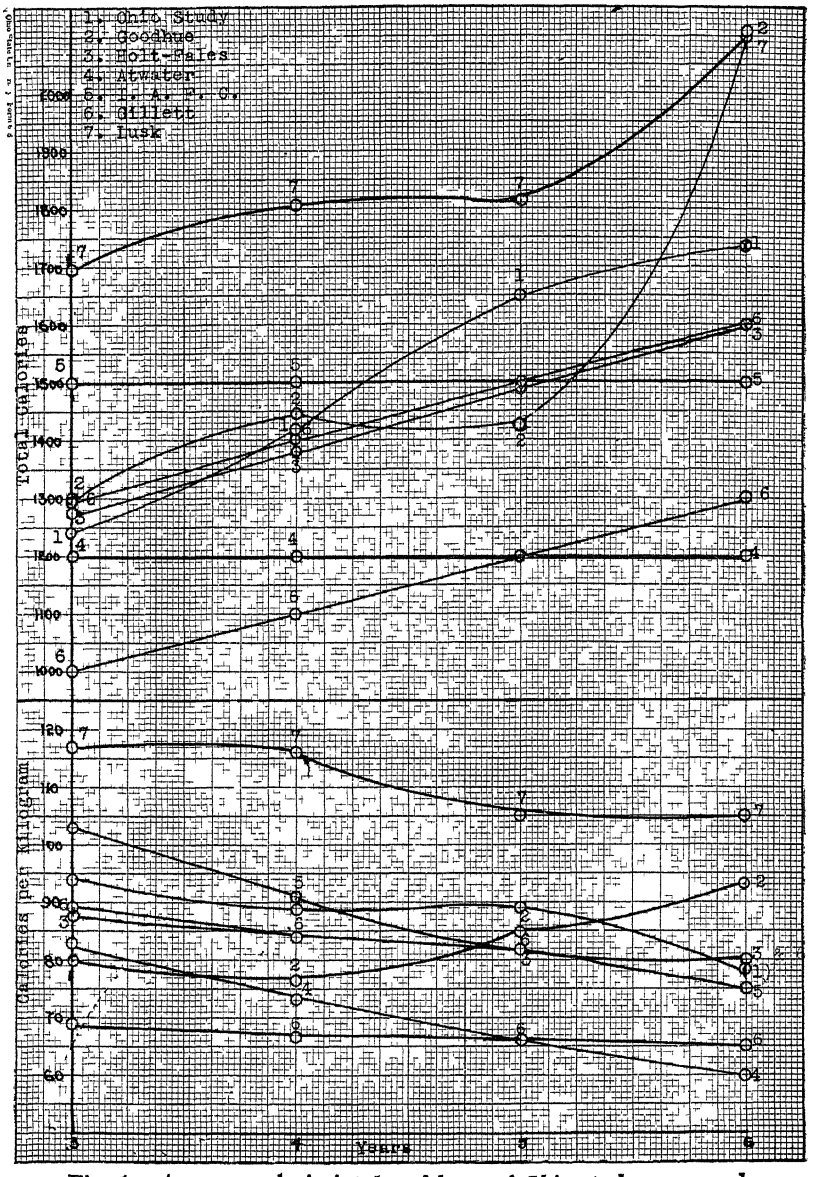

Fig. 1.—Average calorie intake of boys of Ohio study compared to standards and to Goodhue's averages

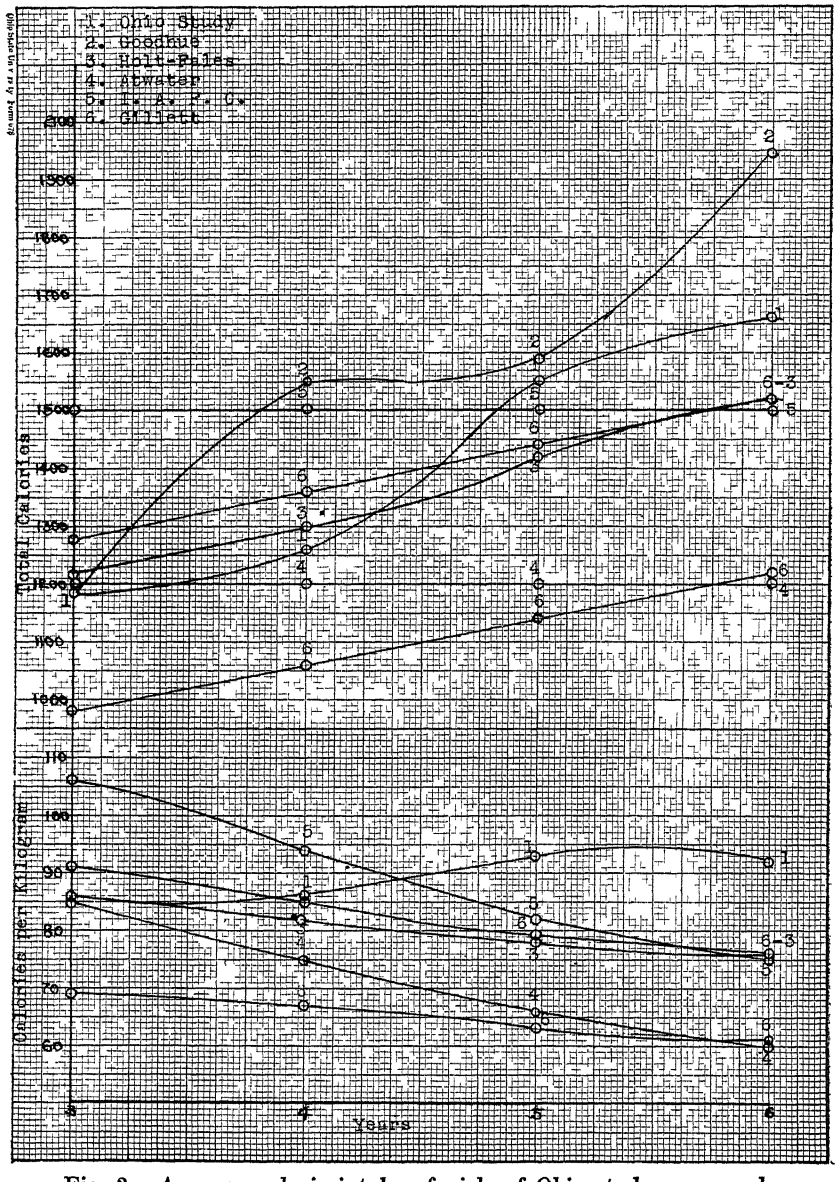

Fig. 2.—Average calorie intake of girls of Ohio study compared to standards and to Goodhue's averages

D. W., an orphanage boy, aged 3 years and 4 months, weighed 17.2 kilograms and was eating only 1138 calories or 66 calories per kilogram as compared to R. H., another orphanage boy aged 3 years and 4 months, who weighed 17.5 kilograms and was eating 1628 calories or 93 calories per kilogram.

Since the weights of all children whose diets were studied compared favorably with the commonly accepted standards of weight for height it would seem that these children were all getting as much food as needed. Just how much the rate of growth might have been accelerated by increased food consumption is an interesting question.

A variation of at least 300 calories in the day by day intake of the four consecutive days is noticed in 16 of the 25 private home children of the study. In some cases the variation is still greater. M. P. ate 1397 calories one day and 1823 the next. R. L. had 1489 calories the first day of the study and 2107 the last day. James W. ate 2094 calories the second day his diet was observed and 1621 calories the third day. J. W., his brother, ate 2102 calories the second day and 1688 the third day. These illustrations of variations would indicate the danger of basing standards of food needs on the observation of amounts of food eaten by children for a single day. Only 11 of the orphanage children show such variations in the day by day intake. All but 2 of the 11 are among the older children.

The frequency distribution of the calorie intake of the entire group of children is shown in Table 3.

TABLE 3.—Frequency Distribution of Calories Taken by Pre-School Children of the Ohio Study

Calories	Boys	Girls	Total
841—900	0	2	2
900—1000	0	0	0
1000—1100	0	1	1
1100—1200	3	4	7
1200—1300	12	6	18
1300—1400	0	4	4
1400—1500	3	2	5
1500—1600	1	3	4
1600—1700	3	2	5
1700—1800	2	4	6
1800—1900	2	0	2
1900—1944	1	0	1

A comparison of the average calorie intake of each age group of the present study with standards as set by Holt and Fales shows that the boys between 2 and 3 were averaging less than the standard, while the averages of the three older groups of boys were

above the standard. On the other hand girls between 2 and 4 had an average below the standard with only the two older age groups exceeding the standard.

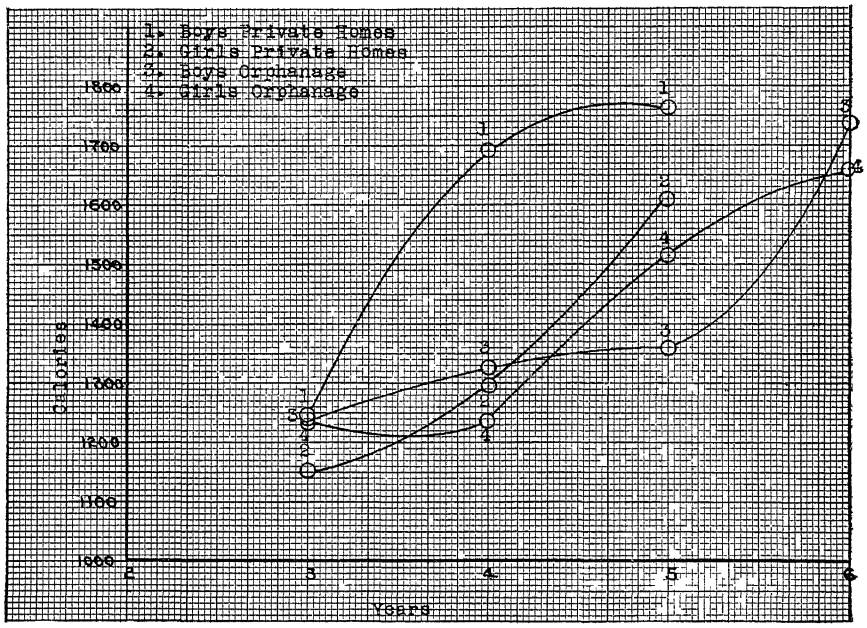

Fig. 3.—Average calorie intake of private home children compared to that of orphanage children

From the standpoint of calories per kilogram 42 of the 55 children studied are above the Holt and Fales standards for corresponding age groups. The average per kilogram calorie intake of the 2 to 3 year girls is below the Holt and Fales standard, that of the 4 to 6 year olds is not only above the Holt and Fales standard but above all other standards given. On the other hand, the average calorie intake of the 5 to 6 year old boys is below the Holt and Fales standard for the corresponding age, that of the boys of the younger age groups more than this standard. From Figure 3 a comparison of the calorie intake of private home children with that of institution children may be made.

PROTEIN

In Table 4 is shown the protein intake of each member of the two groups studied. Table 5 shows commonly accepted standards of protein intake in addition to averages from the Goodhue as well as from the present study. Figures 4 and 5 present this material in graphic form.

TABLE 4.—Daily Protein Intake of Children Included in the Ohio Study

Private Homes					Orphanage				
Child	Total gm.	Grams per kg.	Percent of animal protein	Percent of veg. protein	Child	Total gm.	Grams per kg.	Percent of animal protein	Percent of veg. protein
Boys 2 to 3 years									
R. M.	33	3.0	58	42	T. Z.	34	2.7	55	45
R. R.	40	3.0	70	30	R. S.	36	2.4	56	44
J. A.	47	3.5	77	23	J. S.	36	2.6	51	49
H. T.	42	2.8	61	39	J. H.	35	2.7	50	50
G. C.	49	3.8	65	35					
O. B.	38	2.6	60	40					
J. B.	37	2.7	65	35					
Av.	41	3.1	65	35	Av.	35	2.6	53	47
Girls 2 to 3 years									
I. M.	36	3.1	71	29	P. R.	34	2.7	57	43
M. N.	52	3.4	79	21	B. P.	40	2.6	54	46
P. P.	44	2.9	77	23	L. B.	33	2.6	58	42
P. C.	41	3.1	73	27					
B. B.	43	2.7	70	30					
Av.	43	3.1	74	26	Av.	35	2.6	56	44
Boys 3 to 4 years									
J. W.	68	3.6	76	24	T. H.	37	2.6	54	46
G. M.	44	2.6	71	29	J. C.	34	2.6	55	45
					D. W.	30	1.7	44	56
					J. P.	36	2.3	54	46
					J. DeP	39	2.6	42	58
					R. H.	44	2.5	40	60
Av.	56	3.1	73	27	Av.	37	2.4	48	52
Girls 3 to 4 years									
B. L.	51	3.2	69	31	T. P.	35	2.5	54	46
N. H.	37	2.5	70	30	H. H.	38	2.7	55	45
M. W.	63	3.4	72	28	P. A.	35	2.5	53	47
R. P.	35	2.4	70	30	D. H.	35	2.4	54	46
					C. H.	35	2.2	44	56
					K. R.	30	2.1	41	59
Av.	46	2.9	70	30	Av.	35	2.4	50	50
Boys 4 to 5 years									
J. W.	70	3.3	75	25	B. H.	39	2.5	42	58
C. C.	50	2.7	53	47	T. P.	32	2.1	45	55
D. W.	65	3.3	74	26					
R. L.	62	2.7	66	34					
H. C.	62	3.2	71	29					
Av.	62	3.0	68	32	Av.	35	2.3	43	57

TABLE 4.—Daily Protein Intake of Children Included in the Ohio Study—Continued

Private Homes					Orphanage				
Child	Total gm.	Grams per kg.	Percent of animal protein	Percent of veg. protein	Child	Total gm.	Grams per kg.	Percent of animal protein	Percent of veg. protein
Girls 4 to 5 years									
M. P.	45	2.2	68	32	P. S.	34	2.5	46	54
L. M.	48	2.7	69	31	C. C.	43	2.2	50	50
					C. H.	45	2.9	44	56
Av.	46	2.5	68	32	Av.	40	2.5	46	54
Boys 5 to 6 years									
					D. P.	47	2.0	46	54
					Av.	47	2.0	46	54
Girls 5 to 6 years									
					T. Z.	36	2.4	41	59
					G. W.	46	2.4	42	58
					B. S.	46	2.4	45	55
					N. H.	47	2.3	47	53
					E. P.	44	2.3	44	56
					Av.	44	2.4	44	56
Boys (entire group) 2 to 6 years					Girls (entire group) 2 to 6 years				
Av.	44	2.7	58	42	Av.	41	2.6	57	43

Of the 55 children whose diets were studied, only 9 were eating more total protein than the amounts of the standards for corresponding age groups as given by Holt and Fales. On the other hand only 3 were below the Sherman standard.

Five of the seven private home boys of from 3 to 5 years of age were having more total protein than amounts given in any of the standards. In weight and height these five boys were about a year in advance of the average boys of the same age. The average intake of each age group of the boys from the private homes exceeded the averages for the corresponding age groups as reported by Miss Goodhue.

The frequency distribution of protein taken by the Ohio group is shown in Table 6.

Variation in amounts of protein taken by individual children was not as marked in connection with protein as it was with calories. With the private home children the average protein intake ranged from 33 to 70 grams daily. With the orphanage children

TABLE 5.—Comparison of Standards of Protein Intake With Averages From the Goodhue Study and the Ohio Study

Age	Kilos	Atwater		Inter-Allied Food Commis.		Gillett		Sherman		Holt-Fales		Goodhue		Ohio Study				Total Ohio Study	
														Private Home		Orphanage			
		Grams per kilo	Total	Grams per kilo	Total	Grams per kilo	Total	Grams per kilo	Total	Grams per kilo	Total	Grams per kilo	Total	Grams per kilo	Total	Grams per kilo	Total	Grams per kilo	Total
Boys																			
2—3	14.5	3.2	47	4.1	59	3.3	48	2.0	29	3.3	48	2.13	38.3	3.11	41.104	2.66	35.189	2.94	38.592
3—4	16.4	2.9	47	3.6	59	3.3	54	1.9	31	3.2	52	.....	55.6	3.17	55.900	2.41	36.739	2.60	41.529
4—5	18.2	2.6	47	3.2	59	3.3	60	1.8	34	3.1	56	3.80	55.3	3 09	61.743	2.35	35.461	2.88	54 234
5—6	20.0	2.4	47	2.9	59	3.3	66	1.8	36	3.0	60	2.99	68.9	.....	....	2.07	46.790	2.07	46.790
Girls																			
2—3	14.1	3.3	47	4.2	59	3.3	47	2.0	28	3.3	46	.....	43.4	3.08	43.147	2.67	35.981	2.93	40.459
3—4	15.9	3.0	47	3.7	59	3.3	52	1.9	30	3.1	49	.... ..	48.2	2.93	46.774	2.45	34.580	2.64	39.457
4—5	18.2	2.6	47	3.2	59	3.3	60	1.8	32	2.9	53	.....	51.4	2.54	46.048	2.55	40.434	2.55	42.679
5—6	20.	2.4	47	2.9	59	3.3	66	1.7	34	2.9	57	.....	64.3	.....	.....	2.42	43.769	2.42	43.769

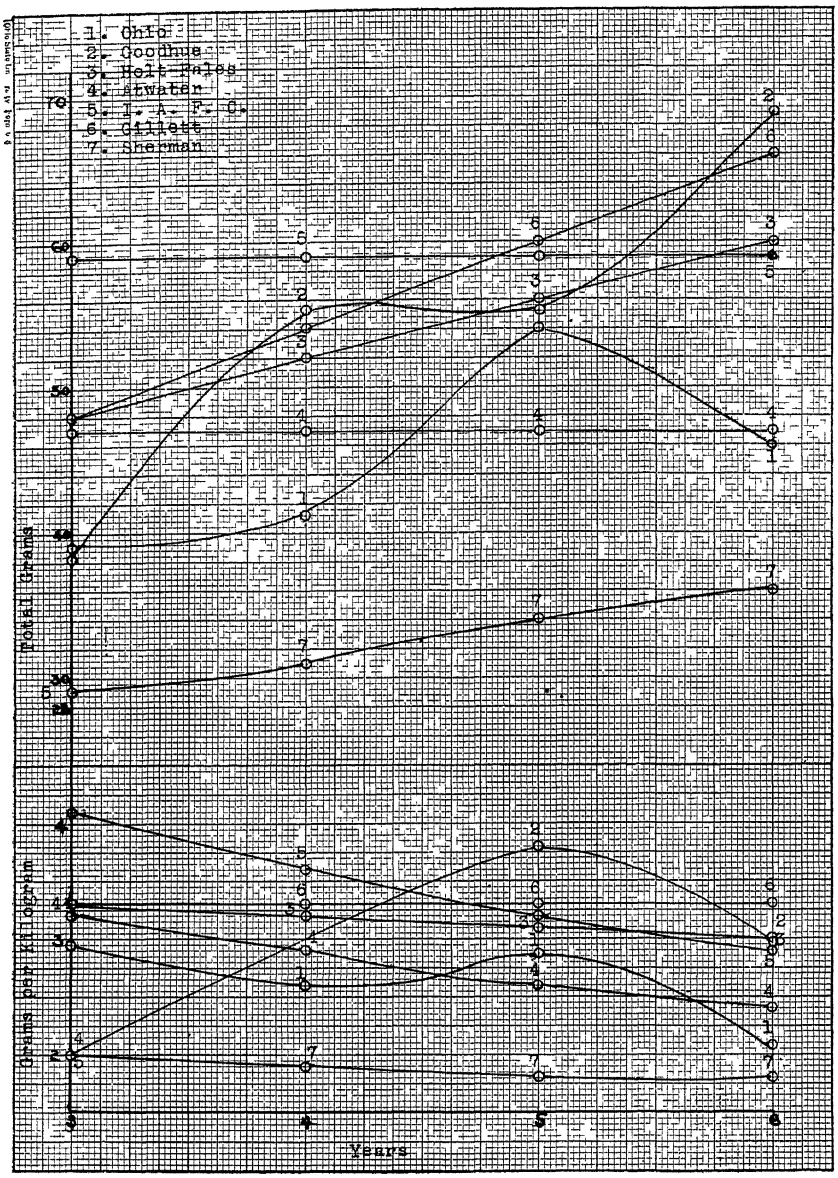

Fig. 4.—Average protein intake of boys of the Ohio study compared to standards and to the Goodhue averages

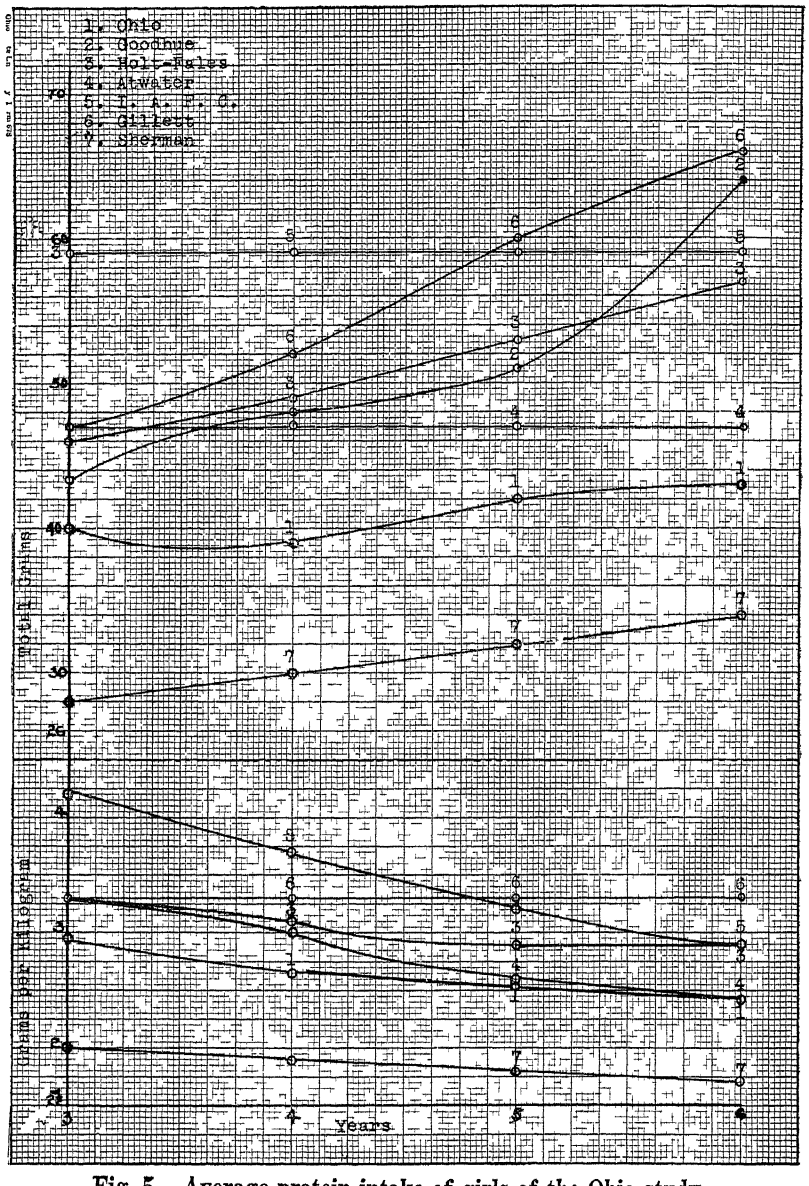

Fig. 5.—Average protein intake of girls of the Ohio study compared to standards and to the Goodhue averages

the range was only from 30 to 47 grams daily. As to the day by day protein intake, only 17 of the 55 children varied the amount of protein eaten by as much as ten grams.

TABLE 6.—Frequency Distribution of Protein in Diets of Pre-School Children of the Ohio Study

Grams of protein	Private homes	Orphanage	Total
29.99—35	1	10	11
35.00—40	5	10	15
40.00—45	7	5	12
45.00—50	4	5	9
50.00—55	2	0	2
55.00—60	0	0	0
60.00—65	4	0	4
65.00—71	2	0	2

The protein per kilogram taken by each of the 55 children compares with the standards in much the same way as does the total protein. With 32 of the children the amount per kilogram is slightly below every standard except Sherman's. However, the protein intake per kilogram varies very little with the Ohio children

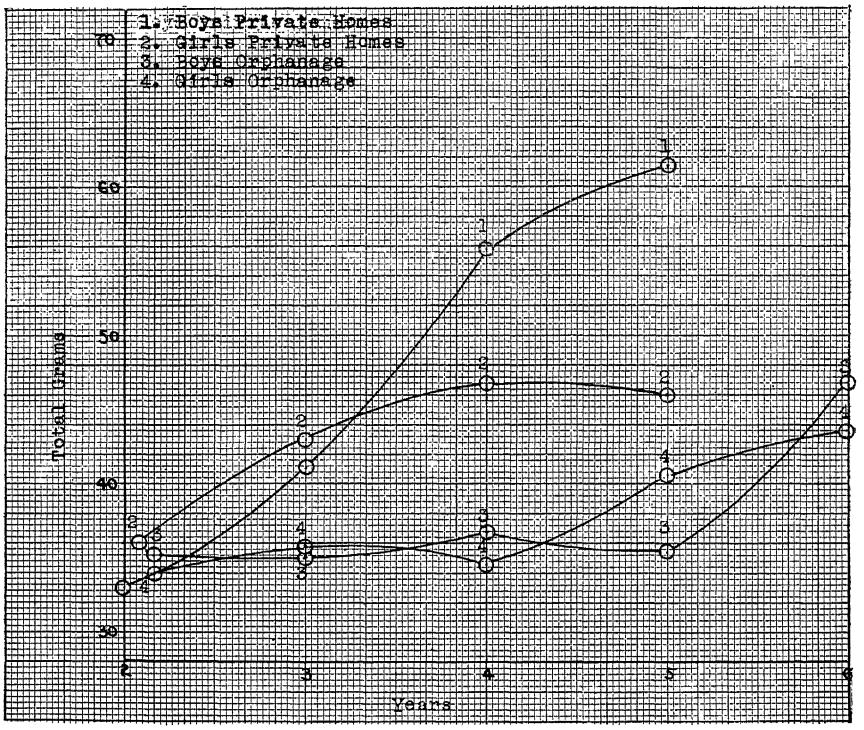

Fig. 6.—Average protein intake of private home children compared to that of orphanage children

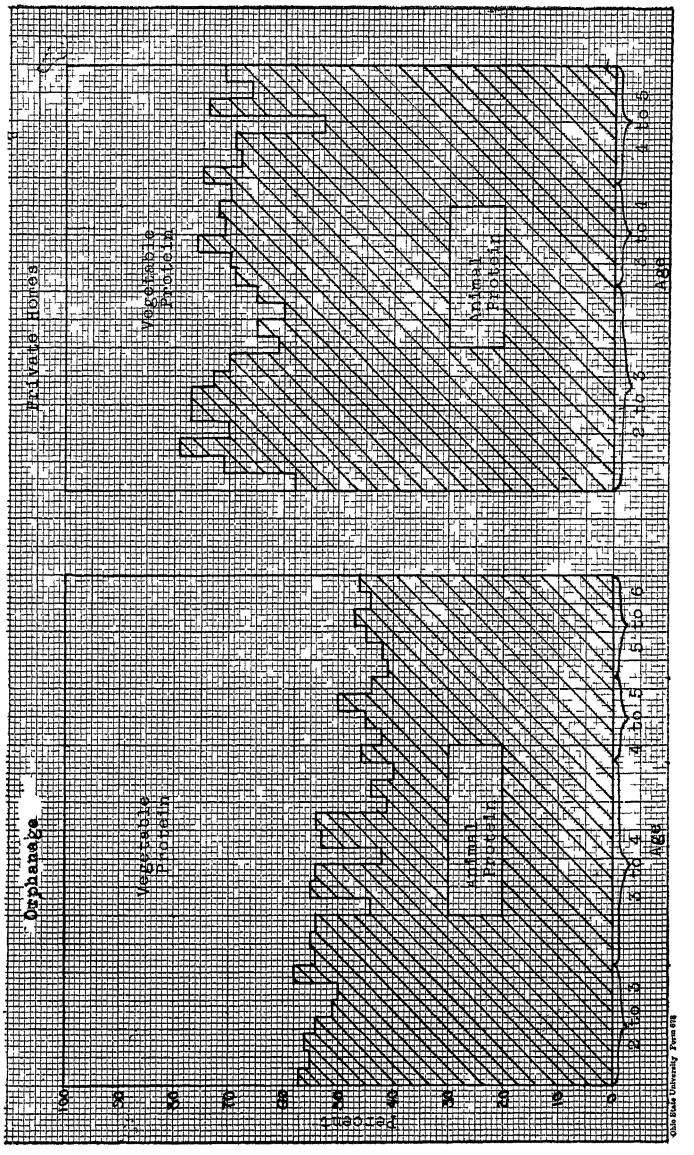

Fig. 7.—Distribution of protein

studied. While Holt reports 8 percent of his group as having less than 2 grams per kilogram daily, and 13 percent as having more than 4; only one of the Ohio group, or 1.8 percent, had less than 2 grams daily and no one had as much as 4 grams daily. As might be expected the private home children were having more protein per kilogram than were the orphanage children. The averages for the private home children were 2.92 grams and 3.11 grams per kilogram for girls and boys, respectively, while the orphanage averages to correspond were 2.50 grams and 2.45 grams. The tendency toward a decrease in protein per kilogram with an increase in age is noticed in the present study but is less marked than in Holt's. Figure 6 shows graphically the protein intake of the private home group as compared to that of the orphanage children.

Since the source of the protein in the diet is of interest, the percentage derived from each source is given, Table 4. Figure 7 gives this material in graphic form. Both boys and girls of the private home group received the greater part of their protein from animal sources, the percentage from this source varying from 58 to 80 percent, with an average of 69.2 percent. On the other hand, the orphanage children were having only from 40 to 58 percent, or an average of 48 percent, of their protein from animal sources.

FAT AND CARBOHYDRATE

Data concerning the average fat and carbohydrate intake of each child for the 4-day period are found in Table 7.

Table 8 shows the average fat intake of boys and girls of the Ohio study as compared with the corresponding intake of the Goodhue study as well as with the Holt and Fales standard. Figure 8 presents this material graphically. Both boys and girls of each age group studied in the private homes averaged more total fat in the diet than did the orphanage children. With one exception these averages also exceed the Goodhue averages for corresponding age groups. The range of fat for the Ohio children studied was from 29 to 76 grams daily. This was less than that of the Goodhue group whose fat intake ranged from 23 to 125 grams daily.

Nevertheless on the basis of fat grams per kilogram it is interesting to note that the average of the 55 children studied in Ohio was 3.4 grams as compared to an average of 3.5 grams for the 35 children of the Goodhue group and 3.4 for the Holt and Fales group.

Fifteen of the private home children of the present study were having more total fat and more fat per kilogram than the amounts of the Holt and Fales standard for the same age groups. Four

TABLE 7.—Daily Fat and Carbohydrate Intake of Children Included in the Ohio Study

Private Homes					Orphanage				
Child	Total fat gm.	Fat per kg. gm.	Total CHO gm.	CHO per kg. gm.	Child	Total fat gm.	Fat per kg. gm.	Total CHO gm.	CHO per kg. gm.
Boys 2 to 3 years									
R. M.	53	4.8	163	14.9	T. Z.	43	3.4	171	12.6
R. R.	53	4.0	141	10.6	R. S.	45	3.1	173	12.1
J. A.	55	4.1	131	9.8	J. S.	47	3.3	180	13.0
H. T.	40	2.7	174	11.8	J. H.	42	3.3	173	13.9
G. C.	56	4.3	193	15.1					
O. B.	51	3.4	163	11.1					
J. B.	38	2.8	155	11.6					
Av.	49	3.7	160	12.1	Av.	44	3.3	175	12.9
Girls 2 to 3 years									
I. M.	30	2.6	107	9.3	P. R.	43	3.4	161	12.8
M. N.	60	3.9	177	11.7	B. P.	51	3.3	194	12.6
P. P.	62	4.1	125	8.4	L. B.	42	3.3	156	12.5
P. C.	48	3.6	124	9.4					
B. B.	47	2.9	139	8.8					
Av.	49	3.4	134	9.5	Av.	45	3.3	170	12.6
Boys 3 to 4 years									
J. W.	75	4.0	226	12.2	T. H.	42	2.9	180	12.6
G. M.	60	3.6	204	12.3	J. C.	42	3.2	164	12.7
					D. W.	40	2.3	170	9.8
					J. P.	47	3.0	170	11.0
					J. DeP.	54	3.6	208	12.0
					R. H.	59	3.3	238	13.5
Av.	68	3.8	215	12.3	Av.	47	3.2	188	11.9
Girls 3 to 4 years									
B. L.	53	3.3	181	11.3	T. P.	42	3.1	170	12.6
N. H.	46	3.1	109	7.3	H. H.	48	3.4	183	13.1
M. W.	49	2.6	203	11.1	P. A.	44	3.1	172	12.5
R. P.	68	4.7	132	9.3	D. H.	42	3.0	171	12.2
					C. H.	47	2.9	195	12.1
					K. R.	39	2.8	175	12.7
Av.	54	3.4	156	9.8	Av.	44	3.1	178	12.5
Boys 4 to 5 years									
J. W.	77	3.6	243	11.6	B. H.	53	3.5	214	14.2
C. C.	57	3.1	230	12.8	T. P.	44	2.9	177	11.7
D. W.	66	3.4	210	10.8					
R. L.	76	3.3	225	10.0					
H. C.	73	3.7	204	10.5					
Av.	70	3.4	222	11.2	Av.	48	3.2	195	12.9
Girls 4 to 5 years									
M. P.	75	3.8	200	10.3	P. S.	43	3.2	187	13.9
L. M.	76	4.4	174	10.1	C. C.	57	2.9	217	11.3
					C. H.	61	3.9	245	15.9
Av.	75	4.1	186	10.2	Av.	53	3.4	216	13.7

TABLE 7.—Daily Fat and Carbohydrate Intake of Children Included in the Ohio Study—Continued

Private Homes					Orphanage				
Child	Total fat gm.	Fat per kg. gm.	Total CHO gm.	CHO per kg. gm.	Child	Total fat gm.	Fat per kg. gm.	Total CHO gm.	CHO per kg. gm.
Boys 5 to 6 years									
					D. P.	68	3.0	234	10.4
					Av.	68	3.0	234	10.4
Girls 5 to 6 years									
					T. Z.	48	3.2	202	13.7
					G. W.	63	3.3	251	13.4
					B. S.	64	3.4	245	13.1
					N. H.	62	3.1	255	12.8
					E. P.	60	3.2	238	12.9
					Av.	60	3.5	238	13.2
Boys (entire group) 2 to 6 years					Girls (entire group) 2 to 6 years				
Av.	54	3.4	190	12.0	Av.	53	3.3	182	11.7

agree with it and 6 were taking less than the standard. On the other hand only 8 children of the institution group are above this same standard. Two agree with it and 20 are below.

The average total carbohydrate intake of the orphanage girls as well as carbohydrate per kilogram exceeded that of the private home girls. On the other hand, orphanage boys had a lower total carbohydrate intake than the private home boys had, but their carbohydrate intake per kilogram was greater than that of the private home boys.

TABLE 8.—Comparison of Average Fat Intake of Children of Ohio Study With Holt and Fales Standard and Goodhue Averages

Age	Holt-Fales		Goodhue		Ohio Study					
					Private Home		Orphanage		Entire Group	
	Grams per kg.	Total	Grams per kg.	Total	Grams per kg.	Total	Grams per kg.	Total	Grams per kg.	Total
Boys										
2—3	3.4	49	2.5	41	3.77	49	3.3	44	3.6	47
3—4	3.3	54	.....	58	3.87	68	3.2	47	3.2	52
4—5	3.2	58	2.7	51	3.48	70	3.2	48	3.2	64
5—6	3.1	62	4.2	96	.....	.....	3.0	68	3.0	68
Girls										
2—3	3.4	48	.....	44	3.40	49	3.3	45	3.4	48
3—4	3.2	51	.....	81	3.40	54	3.1	44	3.2	48
4—5	3.0	55	.....	64	4.10	75	3.4	54	3.7	63
5—6	2.9	59	.....	89	0.00	56	3.5	60	3.5	60

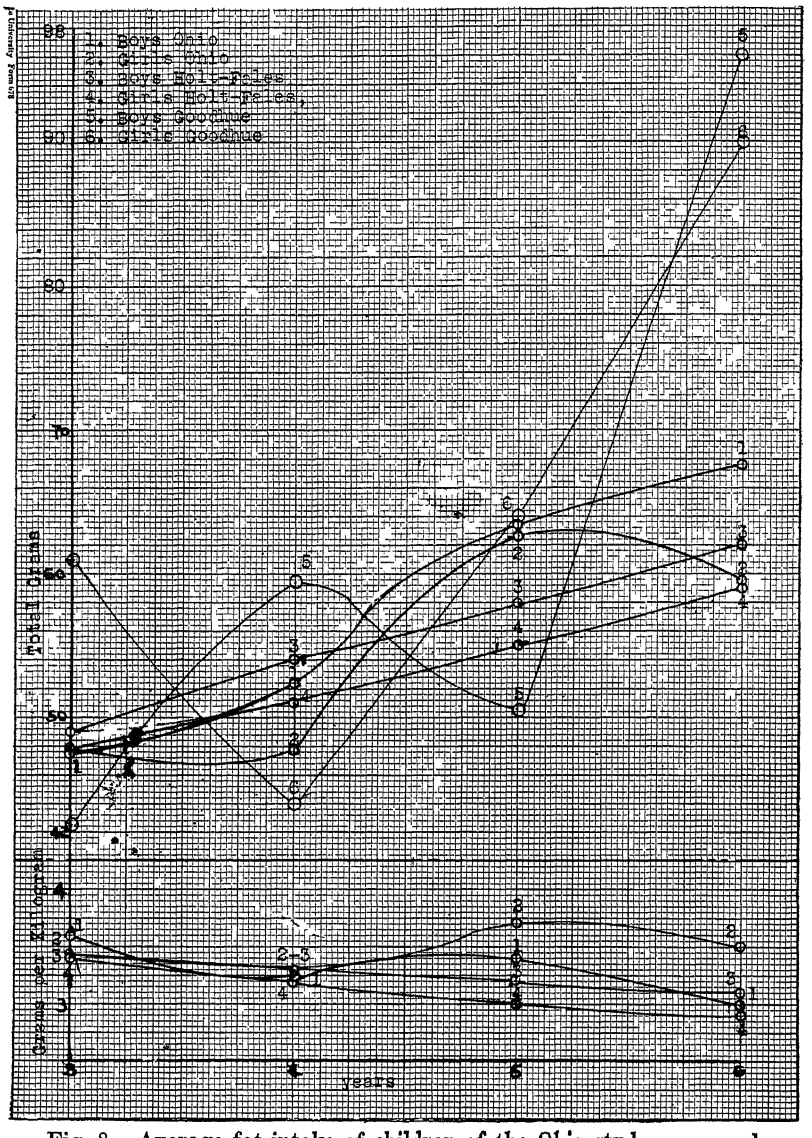

Fig. 8.—Average fat intake of children of the Ohio study compared to Holt and Fales standard and to Goodhue averages

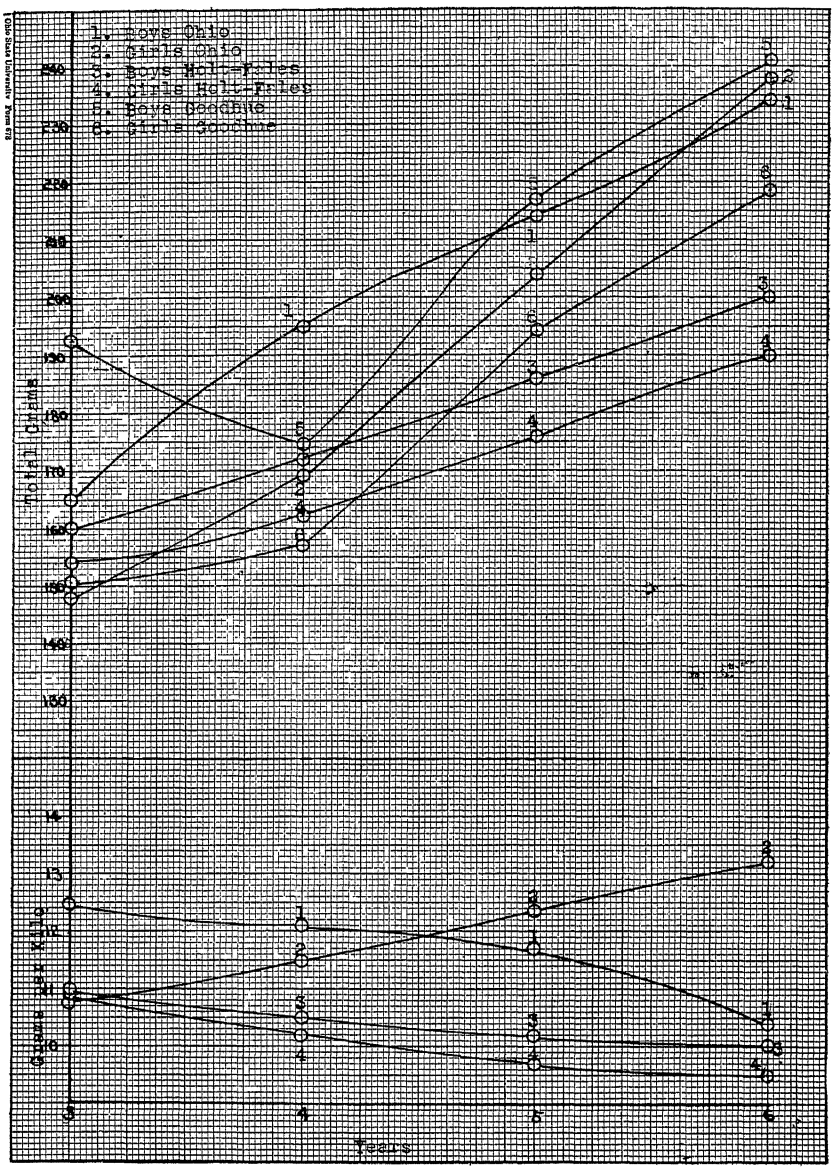

Fig. 9.—Average carbohydrate intake of children of Ohio study compared to Holt and Fales standard and Goodhue averages

Twenty-six of the institution children and 15 of the private home children were exceeding the carbohydrate standard of the Holt and Fales study. Of the remaining 14 children, 5 about equaled the standard and 9 were below. Only 8 children of the entire group were having less carbohydrate per kilogram than the standard of Holt and Fales for children of corresponding age groups. Table 9 shows a comparison of the average carbohydrate intake of children of the Ohio study with the Holt and Fales standard and with the Goodhue averages. Figure 9 shows this comparison graphically.

TABLE 9.—Comparison of Average Carbohydrate Intake of Children of Ohio Study With Holt and Fales Standard and Goodhue Averages

Age	Holt-Fales		Goodhue		Ohio Study				Total Ohio Study	
					Private Home		Orphanage			
	Grams per kg.	Total gr.	Grams per kg.	Total gr.	Grams per kg.	Total gr.	Grams per kg.	Total gr.	Grams per kg.	Total gr.
Boys										
2—3	11.0	160	11.9	193	12.1	160	12.9	175	12.4	165
3—4	10.5	172	.....	174	12.3	215	11.9	188	12.0	195
4—5	10.2	186	12.9	217	11.2	222	12.9	196	11.7	215
5—6	10.0	200	10.6	241	11.8	190	10.4	234	10.4	234
Girls										
2—3	10.0	154	.....	151	9.5	134	12.6	170	10.7	148
3—4	10.2	162	.....	157	9.8	156	12.5	178	11.4	169
4—5	9.7	176	... .	196	10.2	187	13.7	216	12.3	205
5—6	9.5	190	.....	219	.....	... .	13.2	238	13.2	238

PERCENTAGE DISTRIBUTION OF CALORIES

The percentage distribution of the calories between protein, fat, and carbohydrate for each age group for private home children as well as for orphanage children is shown in Table 10. The information for each individual child is given graphically in Figure 10. The percentage distribution of the calories derived from protein, fat, and carbohydrate for the private home group is almost identical with that reported by Holt and Fales and by Goodhue. With the orphanage children, however, a lower percentage of calories from protein with a corresponding increase in the calories from carbohydrate is noticed. This makes the average percentage of calories from protein and from fat for the entire group lower than the standard given by Holt.

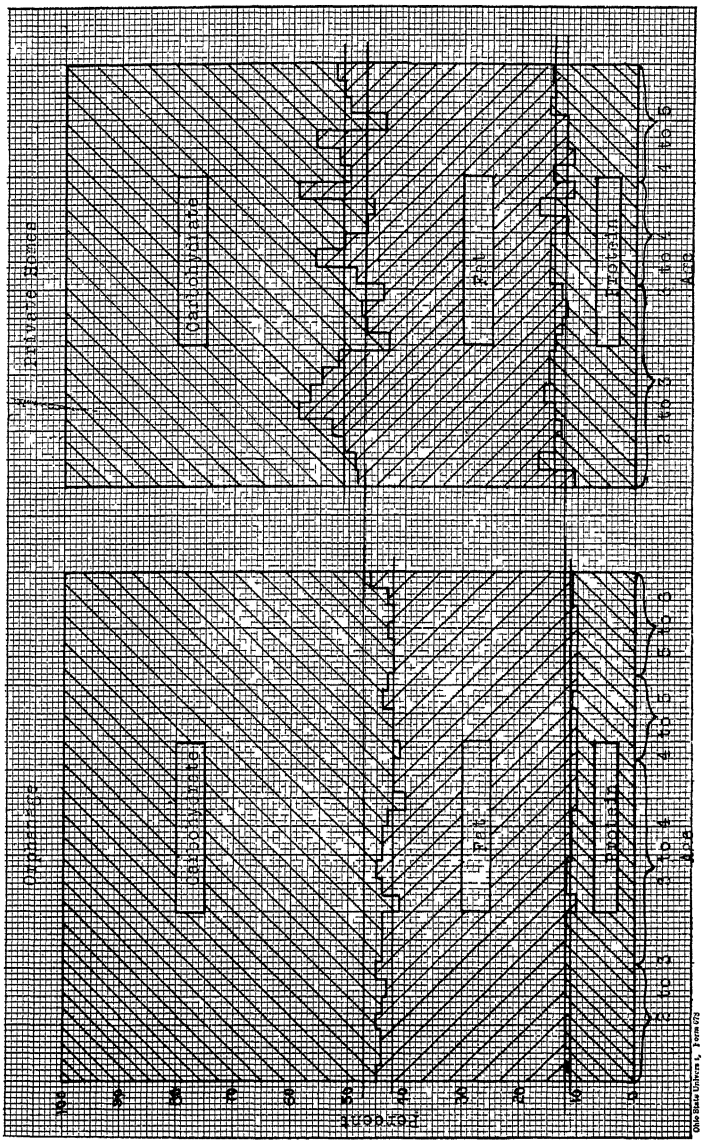

Fig. 10.—Percentage distribution of total calories

TABLE 10.—Percentage Distribution of Total Calories Taken By Children of the Ohio Study

Age group	Number of cases	Protein	at	Carbohydrate
Private Homes				
2—3	12	13.8	36.0	49.4
3—4	6	14.1	37.2	48.6
4—5	7	13.2	37.4	49.7
Average.....	....	14.0	37.0	49.0
Orphanage				
2—3	7	11.7	32.5	55.7
3—4	12	11.0	32.0	56.9
4—5	5	10.2	32.2	57.6
5—6	6	12.4	32.6	57.0
Average.....	.....	11.0	32.0	57.0
Av. for entire group.	....	12.0	35.0	53.0

MINERALS

The average daily amounts of calcium, phosphorus, and iron included in the diet for the 4-day period of the 55 Ohio children studied are shown in Table 11.

Dr. Sherman gives the following standard allowance to provide for the adult man's mineral needs: calcium 0.68 grams, phosphorus 1.44 grams, iron 0.015 grams. In addition he says, "The corresponding allowance for other adults or for families containing children should also be stated as follows":

For children (or families containing children) per 100 calories:

Protein	2.5	grams
Phosphorus	0.048	gram
Calcium	0.023	gram
Iron	0.0005	gram

Using the average calorie intake of each age group of the 55 children studied, Table 12 gives the amount of calcium, phosphorus, and iron which the diets should contain according to Sherman's standard.

More recently Dr. Sherman states, "A study of calcium and phosphorus metabolism in 12 children from 3 to 13 years of age indicated a requirement of at least 1 gram of calcium and phosphorus per day for the growing child" (10). This more recently indicated requirement is also shown for comparison with the corresponding average intake of these minerals for each age group of

TABLE 11.—Daily Calcium, Phosphorus and Iron Intake of Children Included in the Ohio Study

Private Homes				Orphanage			
Child	Grams of Ca.	Grams of P.	Grams of Fe.	Child	Grams of Ca.	Grams of P.	Grams of Fe.
Boys 2 to 3 years							
R. M.	0.74952	0.80310	0.006265	T. Z.	0.86805	0.87434	0.003856
R. R.	0.81577	0.91846	0.008586	R. S.	0.84915	0.84196	0.003912
J. A.	1.30750	1.18924	0.006101	J. S.	0.83926	0.86408	0.004021
H. T.	0.91655	0.99726	0.007161	J. H.	0.78471	0.81792	0.003879
G. C.	1.15943	1.16549	0.007369				
O. B.	0.72048	0.82459	0.006780				
J. B.	0.78363	0.92049	0.005334				
Average	0.92184	0.97409	0.006799	Average	0.83529	0.84957	0.003917
Girls 2 to 3 years							
I. M.	0.70351	0.76433	0.006719	P. R.	0.87963	0.85671	0.003722
M. N.	1.31318	1.29470	0.008794	B. P.	0.94494	0.96542	0.004478
P. P.	0.96765	0.97894	0.006289	L. B.	0.86170	0.83079	0.003701
P. C.	0.88596	0.89187	0.005527				
B. B.	0.92186	0.93087	0.007627				
Average	0.95843	0.97214	0.006991	Average	0.89542	0.88430	0.003967
Boys 3 to 4 years							
J. W.	1.46197	1.50498	0.012342	T. H.	0.88956	0.90682	0.003795
G. M.	1.05180	1.00077	0.005919	J. C.	0.81757	0.82873	0.003860
				D. W.	0.62434	0.70506	0.003919
				J. P.	0.88170	0.87523	0.003927
				J. D.	0.74963	0.84034	0.004602
				R. H.	0.85762	0.96677	0.005279
Average	1.25688	1.25287	0.009130	Average	0.80340	0.85382	0.004230
Girls 3 to 4 years							
B. L.	1.24207	1.29851	0.009316	T. P.	0.81412	0.83874	0.003874
N. H.	0.60501	0.73710	0.007280	H. H.	0.91379	0.92481	0.004008
M. W.	1.17642	1.32377	0.011741	P. A.	0.82672	0.84241	0.003985
R. P.	0.54313	0.68209	0.006451	D. H.	0.82999	0.84891	0.003757
				C. H.	0.70706	0.78148	0.004533
				K. R.	0.59967	0.68158	0.003593
Average	0.89165	1.01036	0.008697	Average	0.78189	0.81965	0.003958
Boys 4 to 5 years							
J. W.	1.48324	1.54172	0.013221	B. H.	0.76859	0.86513	0.004652
C. C.	1.01243	1.09996	0.008461	T. P.	0.68124	0.74362	0.003774
D. W.	1.29741	1.39309	0.009718				
R. L.	1.32836	1.36718	0.011199				
H. C.	1.20369	1.46829	0.011912				
Average	1.26502	1.37404	0.10902	Average	0.72541	0.80437	0.004213
Girls 4 to 5 years							
M. P.	0.96810	1.00505	0.006643	P. S.	0.72131	0.78110	0.004017
L. M.	1.02443	1.03683	0.007638	C. C.	0.92664	0.98785	0.004848
				C. H.	0.93525	1.02065	0.005406
Average	0.99626	1.02094	0.007140	Average	.86106	0.92986	0.004757—

TABLE 11.—Daily Calcium, Phosphorus and Iron Intake of Children Included in the Ohio Study—Continued

Private Homes				Orphanage			
Child	Grams of Ca.	Grams of P.	Grams of Fe.	Child	Grams of Ca.	Grams of P.	Grams of Fe.
Boys 5 to 6 years							
				D. P.	0.94542	1.01694	0.004958
				Average	0.94542	1.01694	0.004958
Girls 5 to 6 years							
				T. Z.	0.69078	0.78641	0.004499
				G. W.	0.94105	1.03281	0.005504
				B. S.	0.94994	1.04197	0.005430
				N. H.	0.99260	1.09116	0.005864
				E. P.	0.92323	0.99414	0.005421
				Average	0.89952	0.98929	0.005343
Boys (entire group) 2 to 6 years				Girls (entire group) 2 to 6 years			
Average	0.95739	1.01264	0.006473	Average	0.88606	0.93753	0.005738

the 55 children whose diets were studied. This material is presented for boys and girls from the private homes as well as from the orphanage in Table 13.

CALCIUM

Of the entire group only 3 had an average of less than the commonly accepted adult standard of 0.68 gram of calcium daily. Thirteen of the 25 private home children were averaging more than Sherman's more recent standard of one gram of calcium daily. The average for the private home group was 1.0257 grams daily as compared to an average for the institution children of 0.833 gram. The average for the entire group was 0.9260 gram. As may be seen in Table 14, 39 children, or 71 percent of the 55 children constituting the entire group were having 0.8 gram or more of calcium daily.

TABLE 12.—Comparison of Mineral Intake of Ohio Group With Sherman's Standard for Each Age Group

Age group	Calorie intake	Sherman Standard of Ca.	Sherman-Hawley Standard of Ca.	Average Ca. intake of Ohio Group	Sherman Standard of P.	Sherman-Hawley Standard of P.	Average P. intake of Ohio Group	Sherman Standard of Fe.	Average Fe. intake of Ohio Group
2—3	1219	0.28057	1.0	0.90907	0.58	1.0	0.93318	0.006095	0.005795
3—4	1330	0.3059	1.0	0.86623	0.63	1.0	0.92156	0.006650	0.005676
4—5	1608	0.36984	1.0	1.09300	0.87	1.0	1.10920	0.008040	0.007624
5—6	1673	0.38479	1.0	0.90717	0.80	1.0	0.99390	0.008365	0.005279
2—6	.....	.....	1.0	0.92108	.....	.....	0.97441	.....	0.006090

TABLE 13.—Average Mineral Intake of Pre-School Children as Shown by the Ohio Study

Age group	Private Homes				Orphanage			
	No. of cases	Calcium	Phosphorus	Iron	No. of cases	Calcium	Phosphorus	Iron
Boys								
2—3	7	0.92184	0.97409	0.006799	4	0.83529	0.84957	0.003917
3—4	2	1.25688	1.25287	0.009130	6	0.80340	0.85382	0.004230
4—5	5	1.26502	1.37404	0.010902	2	0.72541	0.80437	0.004213
5—6	.....	.....	.....	.....	1	0.94542	0.101694	0.004958
Av. 2—6	14	1.09227	1.15675	0.008597	13	0.81214	0.85745	0.004187
Girls								
2—3	5	0.95843	0.97214	0.006991	3	0.89542	0.88430	0.003967
3—4	4	0.89165	1.01036	0.008697	6	0.78189	0.81965	0.003958
4—5	2	0.99626	1.02094	0.007140	3	0.86106	0.92986	0.004757
5—6	.....	.....	.....	.....	5	0.89952	0.98929	0.005343
Av. 2—6	11	0.94103	0.99491	0.007638	17	0.85049	0.90041	0.004508
Av. both sexes	25	1.02572	1.08554	0.008175	30	0.83387	0.88179	0.004375

Since Sherman and Hawley have conclusive experimental evidence that the calcium of milk is utilized to better advantage than is calcium from vegetables, (4) it seemed worth while to determine the amount and the percentages of calcium derived from the most commonly used foods in the diets of these children. Table 15 shows the results of the computation. Fifty-eight percent of the group were receiving between 80 to 90 percent of their total calcium from milk, while for 40 percent of the group 70 to 80 percent of the total calcium came from this same food. The remaining 2 percent of the group were getting from 60 to 70 percent of their calcium in this way. In other words, 98 percent of the children were having at least 70 percent of their calcium from milk. Since these children were all in good physical condition, the fact that the greater part of the calcium of the diet was from milk would seem to offer additional evidence of the excellent utilization of the calcium of milk by children.

TABLE 14.—Frequency Distribution of Calcium in Diets of Pre-School Children of the Ohio Study

Grams of calcium	Private Homes		Orphanage		Total	
	Number	Percent	Number	Percent	Number	Percent
1.0 and over	13	52	0	0	13	23
0.9–1.0	4	16	9	30	13	23
0.8–0.9	2	8	11	40	13	23
0.7–0.8	4	16	6	20	10	18
0.68–0.7	0	0	2	6	2	3
Below 0.68	2	8	2	6	4	7

As sources of calcium cereals supplemented milk in the diet of the orphanage children to a greater extent than they did for the private home children. For 83 percent of the orphanage group from 7 to 12 percent of the calcium in the diet was derived from cereals, while only 8 percent of the private home group had as much as 7 to 9 percent of the calcium from this source.

TABLE 15.—Percentage of Calcium Derived From Various Sources in the Diets of Children Included in the Ohio Study

Percent	Number of cases					
	Private Homes		Orphanage		Total	
	No.	Pct.	No.	Pct.	No.	Pct.
Milk						
80—90	16	64	16	53	32	58
70—80	8	32	14	47	22	40
69—70	1	4	0	0	1	2
Meat and fish						
1—1.93	1	4	0	0	1	2
0.03—1.0	22	88	0	0	22	40
0.00	2	8	30	100	32	58
Fruits						
7—10.3	3	12	0	0	3	5
4—7	14	56	0	0	14	26
3—4	3	12	0	0	3	5
2—3	3	12	11	13	14	26
1.22—2	2	8	19	63	21	38

Percent	Number of cases					
	Private Homes		Orphanage		Total	
	No.	Pct.	No.	Pct.	No.	Pct.
Eggs						
5—6.13	3	12	0	0	3	5
3—4	0	0	0	0	0	0
1—3	19	76	0	0	19	34
.004—1	3	12	30	100	33	60
Cereals						
9—11.5	0	0	8	26	8	15
7—9	2	8	17	57	19	35
5—7	0	0	5	17	5	9
3—5	13	52	0	0	13	23
0.6—3	10	40	0	0	10	18
Vegetables						
7—10	6	24	22	73	28	51
4—7	13	52	8	27	21	38
2—4	5	20	0	0	5	9
1.88—2	1	4	0	1	1	2

Fruit supplied a larger percentage of the calcium for the private home group than it did for the orphanage group, while the reverse was true for vegetables.

Since meat contains very little calcium and since 32 of the children had no meat at all during the 4-day period of the study, it is evident that as a source of calcium for this group of children it is unimportant. On the other hand, eggs contributed considerably to the calcium of the diet of the private home children and very little to the calcium of the orphanage children.

PHOSPHORUS

Altho in all but 3 cases, each of the 55 children was having more calcium daily than the amount of the adult standard, in only 3 cases did the corresponding phosphorus intake exceed the adult standard. All the other cases were below. Table 11. Thirty-four

percent of the group averaged more than 1 gram of phosphorus daily, and 48 percent averaged between 0.8 and 1 gram each day. See Table 16.

TABLE 16.—Frequency Distribution of Phosphorus in Diets of Pre-School Children of the Ohio Study

Phosphorus	Private Homes		Orphanage		Total	
Grams	*No.*	*%*	*No.*	*%*	*No.*	*%*
1.44 or above	3	12	0	0	3	5
1.00–1.44	11	44	5	16	16	29
0.90–1.00	5	20	6	20	11	20
0.80–0.90	3	12	13	43	16	29
0.70–0.80	2	8	5	16	7	12
0.60–0.70	1	3	1	3	2	8

Since 83 percent of the group were having an average of more than 0.8 gram of phosphorus, it would seem safe to say that children should have at least that amount of phosphorus daily. Moreover, since practically all the children exceeded the adult standard of calcium and practically none reached the corresponding standard for phosphorus, it would seem that in neither case is the adult standard a suitable one for children.

Since calcium and phosphorus are interdependent in their relationship in the body, the differences in the amounts of each taken by individual children have been noted and recorded in Table 17.

TABLE 17.—Differences in Amounts of Calcium and Phosphorus in Individual Diets of Pre-School Children of the Ohio Study

	Number of cases	Percent
Phosphorus exceeds Calcium		
Less than 0.05 gram difference	22	40
From 0.05 to 0.10 gram	23	41
From 0.10 to 0.20 gram	7	13
More than 0.20 gram	1	1
Calcium exceeds phosphorus		
From 0.05 to 0.10 gram	2	3

For 22 of the children the phosphorus intake exceeded that of calcium by less than 0.05 gram, while for 23 of the group the difference was from 0.05 to 0.1 gram. Seven children were having as much as from 0.1 to 0.2 gram more phosphorus than calcium, and only one child was exceeding the 0.2 difference. Of the 55 children, only 2 had more calcium than phosphorus.

As with calcium, the sources of the phosphorus intake of individual children have been calculated. Table 18 gives this information.

All the orphanage children and 87 percent of the private home group, or 92 percent of the entire group, were getting over half of their phosphorus from milk. If the calcium of milk is utilized to good advantage it would seem probable that such would be the case with phosphorus.

TABLE 18.—Percentages of Phosphorus Derived From Various Sources in the Diet of Pre-School Children of the Ohio Study

Percent	Number of cases						Percent	Number of cases					
	Private Homes		Orphanage		Total			Private Homes		Orphanage		Total	
	No.	Pct.	No.	Pct.	No.	Pct.		No.	Pct.	No.	Pct.	No.	Pct.
Milk							**Eggs**						
70—86	2	8	0	0	2	4	8—10.8	4	16	0	0	4	7
60—70	11	44	13	43	24	44	6—8	6	24	0	0	6	11
50—60	9	36	17	57	26	47	4—6	5	20	0	0	5	10
44—50	3	12	0	0	3	5	2—4	9	36	0	0	9	16
							0.009—1	1	4	30	100	31	56
Meat and fish							**Cereals**						
8—17	6	24	0	0	6	11	25—29.8	1	4	12	40	13	23
6—8	2	8	0	0	2	3	20—25	3	12	15	50	18	32
4—6	7	28	0	0	7	13	15—20	2	8	3	10	5	10
0.7—4	8	32	0	0	8	15	10—15	11	44	0	0	11	20
0.00	2	8	30	100	32	58	5—10	7	28	0	0	7	13
							4—5	1	4	0	0	1	2
Fruits							**Vegetables**						
7—9.8	3	12	0	0	3	5	10—13.3	11	44	11	37	22	40
4—7	13	52	3	10	16	29	7—10	11	44	16	53	27	49
3—4	5	20	11	37	16	29	4.1—7	3	12	3	10	6	11
2—3	2	8	16	53	18	33							
0.9—2	2	8	0	0	2	4							

Eggs as well as meat and fish were more conspicuous as sources of phosphorus for the private home group than they were for the orphanage children. Cereals provided more than 15 percent of the total phosphorus for the entire orphanage group. Only 6 of the private home children, however, received as much as 15 percent of their phosphorus from cereals.

Fruits were more evident as sources of phosphorus for the private home group than for the orphanage group. The percentage of phosphorus derived from vegetables was about the same for each of the two groups.

IRON

Table 13 shows the average iron intake for each age group of the private home children as well as for the orphanage children with averages of the two combined. Comparison with the Sherman standard shows that for each age group the private home chil-

dren were getting more iron in proportion to their calorie intake than the standard. For the orphanage children however, the reverse is the case since no age group reached the Sherman standard for the corresponding age.

TABLE 19.—Frequency Distribution of Iron in Diets of Pre-School Children of the Ohio Study

Grams	Private Home	Orphanage	Total
0.011—0.0132	5	0	5
0.009—0.011	2	0	2
0.008—0.009	3	0	3
0.007—0.008	5	0	5
0.006—0.007	7	0	7
0.005—0.006	3	6	9
0.004—0.005	0	10	10
0.003—0.004	0	14	14

Variations in the amounts of iron in the diets of the group of 55 children were quite marked, ranging from 0.003 gram daily to 0.011 gram (Table 11). No private home children reached the lower level while no orphanage child reached the upper level. Table 19 shows the frequency distribution of iron in the diets studied.

SOURCES OF IRON IN THE DIET

Altho generally considered a poor source of iron, it is interesting to see that 58 percent of the entire group were receiving more than one-fourth of their iron from milk. Sherman has stated that the iron of milk is utilized to better advantage than is the iron of meat (8).

No meat was served at the orphanage during the period of the study, but for 19 of the private home children more than 10 percent of the total iron was from meat. While for both boys and girls cereals furnished a relatively high percentage of the iron, for 24 of the orphanage children it furnished more than 25 percent of the total iron.

For 43 children, or 78 percent of the entire group, over 10 percent of the iron was derived from fruit. Vegetables contributed more to the iron of the diet than did fruits, since 44, or 80 percent of the entire group, were getting more than 21 percent of their iron from vegetables, and no child had as much as 21 percent of the iron intake from fruit. Table 20 presents this information.

While all the children whose diets were studied were in good physical condition as evidenced by the weight for height index, and by a physical examination, 8 of the children were outstandingly in advance of standards of height and weight for their ages.

Table 21, which shows the actual age of each of these children, gives the age to which each corresponded according to height and also according to weight. The calories, protein, calcium, phosphorus, and iron in the diet of each of these children is also shown. It is probably not merely coincidence that each of these children was eating more food than the other children of the same age group. In addition the fact that these 8 children also exceeded the others of the same age group in amounts of protein, phosphorus, calcium, and iron in the diet would seem to indicate that growth in children is accelerated by liberal amounts of tissue building foods in the diet.

TABLE 20.—Percentage of Iron Derived From Various Sources in the Diet of Pre-School Children of the Ohio Study

Percent	Number of cases					
	Private Homes		Orphanage		Total	
	No.	Pct.	No.	Pct.	No.	Pct.
Milk						
35 —38.1	1	4	10	33	11	20
30 —35	1	4	5	17	6	11
25 —30	5	20	10	33	15	27
20 —25	5	20	5	17	10	18
15 —20	10	40	0	0	10	18
12.7—15.0	3	12	0	0	3	6
Meat and fish						
18—34	1	4	0	0	1	2
15—18	2	8	0	0	2	4
10—15	6	24	0	0	6	10
5—10	10	40	0	0	10	18
1— 5	4	16	0	0	4	8
0.00	2	8	30	100	32	58
Fruits						
18 —20.7	3	12	0	0	3	5
15 —18	2	8	4	13	6	10
12 —15	5	20	15	50	20	36
10 —12	3	12	11	37	14	26
5 —10	8	32	0	0	8	15
2.4— 5	4	16	0	0	4	7

Percent	Number of cases					
	Private Homes		Orphanage		Total	
	No.	Pct.	No.	Pct.	No.	Pct.
Eggs						
15—20	2	8	0	0	2	4
12—15	7	28	0	0	7	13
10—12	6	24	0	0	6	11
8—10	4	16	0	0	4	7
0.2—8	6	24	0	0	6	11
Less than 0.2	0	0	30	100	30	54
Cereals						
30—36.8	1	4	13	43	14	25
25—30	2	8	11	37	13	23
20—25	2	8	6	20	8	14
15—20	5	20	0	0	5	10
10—15	12	48	0	0	12	22
6—10	3	12	0	0	3	5
Vegetables						
40 —43	1	4	0	0	1	1
35 —40	2	8	0	0	2	3
30 —35	8	32	0	0	8	14
25 —30	6	24	9	30	15	27
21 —25	4	16	14	47	18	32
10.6—21	4	16	7	23	11	20

SUMMARY

The children whose diets were considered in this study were in good physical condition as shown by the height and weight index and by a physical examination given each child by Dr. E. H. Baxter, a pediatrician on the staff of the College of Medicine of the Ohio State University.

The actual food eaten by each of 55 children was weighed for a period of four consecutive days. Data collected in this manner were classified and results tabulated. A summary of results follows:

CALORIES

The average daily calorie intake of the group was 1418 for the boys and 1363 for the girls with an average intake per kilogram of 91 calories and 88 calories, respectively. The average calorie intake of the children from two to six increased with age. It would seem therefore that such standards as have not considered the differences in calorie intake for the different age groups might be discarded.

TABLE 21.—Height and Weight With Food Intake of Eight Children Who Were in Advance of Standards of Height and Weight

Child	Age	Height	Reaches height standard	Weight	Reaches weight standard	Food intake					
						Cal.	Protein	Animal protein	Ca.	Phosphorus	Fe.
	Yr. Mo.	*In.*	*Yr. Mo.*	*Lb.*	*Yr. Mo.*		*Gm.*	*Pct.*	*Gm.*	*Gm.*	*Gm.*
M. N.	2 4	36.0	2 9	33.25	3 9	1,450	52	79	1.31318	1.29470	0.008794
B. S.	3 2	38.6	3 9	35.12	4 0	1,410	51	69	1.24207	1.29851	0.009316
J. W.	3 4	40.2	4 4	40.5	4 10	1,852	68	76	1.46197	1.50498	0.12342
M. W.	3 5	38.5	3 8	39.93	5 0	1,505	63	72	1.17642	1.32377	0.011741
J. W.	4 2	43.8	6 0	45.8	6 2	1,944	70	75	1.48325	1.54172	0.013221
D. W.	4 7	42.7	5 6	42.5	5 4	1,690	65	74	1.29741	1.39309	0.009718
R. L.	4 7	43.3	5 8	49.0	7 0	1,838	62	66	1.32836	1.36718	0.011199
H. C.	4 10	41.2	4 9	42.0	5 4	1,718	62	71	1.20369	1.46829	0.011912

The average calorie intake of girls as well as of boys from four to six exceed every corresponding standard except that given for Lusk's active boy. Altho the degree of activity of each child of the Ohio study could not be ascertained, it would seem from such observations as were made that the children would be designated as "active" by Lusk. It would therefore seem that the Lusk standard is too high for the pre-school child while other standards for children from four to six are too low. It may be that activity during these two years is greatly increased over that of the preceding two years and should be considered in any standard of calorie intake.

The amount of food eaten varies greatly from individual to individual and with the same child from day to day. The relation of calorie intake to growth offers possibilities for future study.

PROTEIN

The average daily protein consumption was 44 grams for boys and 41 grams for girls with a per kilogram intake of 2.79 grams and 2.66 grams for boys and girls, respectively. For the entire group 12 percent of the calories were derived from protein.

Protein intake for each age group of the private home children exceeded that of corresponding age groups for the orphanage children. Children who had a high protein intake were in advance in height and weight of the average child of the same age.

FAT AND CARBOHYDRATE

The average fat consumption was 54 grams daily for boys and 53 grams daily for girls, with an average per kilogram intake of 3.44 grams and 3.39 grams for boys and girls, respectively. For the entire group 35 percent of the total calories were derived from fat.

As with protein, the fat intake for each age group of the private home children exceeded that of corresponding age groups of the institution children.

The average total carbohydrate intake of the group was 190 grams daily for the boys and 182 grams for the girls, with 12.07 grams and 11.73 grams per kilogram for boys and girls, respectively. For the entire group an average of 53 percent of the calories were derived from carbohydrate, with an average of 49 percent for the private home children and 57 percent for the institution children, respectively.

MINERALS *CALCIUM*

The average calcium intake for the entire group was 0.92108 gram with an average of 1.0257 grams for the private home group as compared to 0.83387 gram for the institution children. The principal source of calcium for all these children was milk. Every child whose diet was studied had some milk, the amounts used by individual children ranging from about one-third of a quart to one quart daily.

PHOSPHORUS

The average for the groups was 0.9744 gram, with an average for the private home group of 1.08554 grams as compared to 0.88179 gram for the institution children.

It would seem from these data that the adult standard of phosphorus of 1.44 grams is unsuited to children but that at least 0.8 gram of phosphorus should be provided in the child's daily diet. For the majority of the children the amount of phosphorus slightly exceeded the amount of calcium in the diet. For only two children was the reverse true.

As with calcium, the principal source of phosphorus in the diet was milk. Cereals ranked next in importance, as sources of phosphorus.

IRON

The average intake for the group was 0.006099 gram, with an average of 0.008175 gram for the private home children as compared to 0.004375 gram for the institution group.

Cereals and vegetables were the principal sources of iron, with milk and fruits providing lesser amounts. For the private home children meat and eggs were important sources of iron.

VITAMINS

No data are available by which the vitamin content of the diet could be studied quantitatively. From the liberal use of milk and vegetables it would seem that these dietary essentials were adequately provided.

APPENDIX

TABLE 22.—Age, Height, and Weight of Children From Private Homes

Name	Sex	Age		Height	Weight		Standard weight	Above or below(—) standard weight	Difference in percentage
		Yr.	*Mo.*	*In.*	*Lb.*	*Kg.*	*Lb.*	*Lb.*	*Pct.*
R. M.	M.	2	0	32.4	24.0	10.90	25.01	—1.01	— 4.0
I. Mc.	F.	2	1	32.0	25.0	11.36	24.80	0.20	2.0
M. N.	F.	2	4	36.0	33.2	15.10	30.00	3.25	10.0
R. R.	M.	2	5	35.2	29.2	13.27	28.90	0.30	1.0
P. P.	F.	2	5	35.3	32.8	14.91	29.02	3.78	13.0
J. A.	M.	2	6	36.0	29.1	13.22	30.00	—0.90	— 3.0
P. C.	F.	2	8	35.4	28.8	13.09	29.16	—0.36	— 1.0
B. B.	F.	2	10	36.8	34.5	15.68	31.20	3.30	10.0
H. T.	M.	2	10	37.0	32.3	14.68	31.60	0.70	2.0
G. C.	M.	2	10	35.2	28.0	12.72	28.90	—0.90	— 3.0
O. B.	M.	2	11	37.7	32.3	14.68	32.72	—0.42	— 1.0
J. B.	M.	2	11	35.7	29.5	13.40	29.60	—0.10	— 0.2
B. LeV.	F.	3	2	38.6	35.1	15.90	34.50	0.60	1.0
N. H.	F.	3	4	38.0	32.3	14.70	32.70	—0.40	— 1.0
J. W.	M.	3	4	40.2	40.5	18.40	38.40	2.10	5.0
G. M. C.	M.	3	5	39.9	36.3	16.50	38.00	—1.70	— 4.0
M. W.	F.	3	5	38.5	39.9	18.15	34.20	5.70	14.0
R. P.	F.	3	7	37.9	31.0	14.09	32.50	—1.50	— 3.0
J. W.	M.	4	2	43.8	45.8	20.82	45.00	0.80	1.0
N. P.	F.	4	3	42.0	42.6	19.37	41.20	1.40	3.0
L. M.	F.	4	4	39.7	37.5	17.04	36.89	0.61	1.0
C. C.	M.	4	5	40.5	39.5	17.95	38.90	0.60	1.0
D. W.	M.	4	7	42.7	42.5	19.30	42.96	—0.46	— 1.0
R. L.	M.	4	7	43.3	49.0	22.30	44.07	4.93	12.0
H. C.	M.	4	10	41.2	42.5	19.34	40.10	2.40	6.0

TABLE 23.—Age, Height, and Weight of Children From Orphanage

Name	Sex	Age		Height	Weight		Standard weight	Above or below (—) standard weight	Difference in percentage
		Yr.	*Mo.*	*In.*	*Lb.*	*Kg.*	*Lb.*	*Lb.*	*Pct.*
P. R.	F.	2	2	33.00	27.5	12.5	26.0	1.5	5.4
T. Z.	M.	2	2	35.12	29.7	13.5	28.7	1.0	3.0
R. S.	M.	2	4	32.50	31.5	14.3	25.4	6.1	24.0
B. P.	F.	2	7	32.75	33.7	15.3	25.7	8.0	31.0
J. S.	M.	2	9	34.50	30.5	13.8	27.9	2.6	8.0
J. H.	M.	2	10	34.25	27.2	12.4	27.6	—0.4	— 1.0
L. B.	F.	2	10	32.25	27.5	12.5	25.1	2.4	8.0
T. H.	M.	3	0	34.25	31.6	14.3	27.6	4.0	14.0
J. C.	M.	3	2	35.25	28.5	12.9	28.9	—0.4	— 1.0
T. P.	F.	3	4	33.75	29.7	13.5	26.9	2.8	10.0
D. W.	M.	3	4	37.75	38.0	17.2	32.8	5.2	15.0
H. H.	F.	3	5	37.00	30.7	13.9	31.5	—0.8	— 2.0
J. P.	M.	3	7	37.12	34.0	15.4	31.6	2.4	7.0
J. DeP.	M.	3	7	38.25	32.5	14.7	33.9	—1.4	— 4.0
P. A.	F.	3	8	33.25	30.2	13.7	26.3	3.9	15.0
D. H.	F.	3	8	35.50	30.6	13.9	29.2	1.4	4.0
K. R.	F.	3	9	35.75	30.1	13.7	29.6	0.5	1.0
C. H.	F.	3	11	39.00	35.2	16.0	35.7	—0.5	— 1.0
R. H.	M.	3	11	41.00	38.5	17.5	39.8	—1.3	— 3.0
P. S.	F.	4	1	35.75	29.5	13.4	29.6	—0.1	— 0.3
B. H.	M.	4	5	37.25	33.0	15.0	32.0	1.0	3.0
T. P.	M.	4	8	36.75	33.2	15.1	31.2	2.0	7.0
C. C.	F.	4	10	43.25	42.2	19 2	43.5	—1.3	— 2.0
C. H.	F.	4	11	38.75	33.7	15.3	34.9	—1.2	— 3.0
T. Z.	F.	5	0	37.50	32.5	14.7	32.1	0.4	1.0
G. W.	F.	5	1	41.25	41.2	18.7	39.7	1.5	3.0
B. S.	F.	5	7	41.30	41.0	18.6	39.8	1.2	3.0
N. H.	F.	5	8	44.00	43.6	19.8	44.8	—1.2	— 2.0
E. P.	F.	5	9	41.80	40.6	18.4	40.8	—0.2	— 0.4
D. P.	M.	5	11	44.25	49.5	22.5	45.8	3.7	8.0

CHILD	DATE OF BIRTH	DATE OF ENTRANCE INTO ORPHANAGE
P. R.	November 30, 1923	January 14, 1924
T. P.	December , 1923	December 5, 1925
R. S.	October 12, 1923	October 2, 1925
B. P.	July 11, 1923	November 16, 1924
J. S.	May 5, 1923	April 15, 1925
J. H.	March 19, 1923	August 27, 1925
L. B.	March 23, 1923	March 23, 1923
T. H.	January 23, 1923	January 23, 1923
J. C.	December 7, 1922	November 18, 1925
T. P.	October 6, 1922	August 7, 1924
D. W.	October 9, 1922	October 9, 1922
H. H.	August 27, 1922	December 11, 1922
J. DeP.	June 19, 1922	March 22, 1925
J. P.	August , 1922	October 15, 1924
D. H.	May 22, 1922	May 26, 1923
P. A.	June 10, 1922	January 14, 1926
C. R.	April 21, 1922	January 14, 1924
C. H.	February 25, 1922	January 13, 1923
R. H.	February 25, 1922	January 13, 1923
P. S.	December 24, 1921	October 2, 1925
B. H.	September 13, 1921	June 28, 1925
T. P.	June , 1921	October 15, 1924
C. C.	April 11, 1921	October 2, 1925
C. H.	March 10, 1921	May 26, 1923
T. Z.	February , 1921	December 5, 1925
G. W.	December 18, 1920	October 9, 1922
B. S.	July 12, 1920	October 25, 1923
N. H.	June 5, 1920	December 2, 1923
E. P.	May 4, 1920	November 15, 1924
D. P.	March , 1920	October 15, 1924

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